THE VALUE OF BARNYARD MANURE.

COMPOSITION OF MANURE.
THE RE-ENFORCEMENT OF MANURE.
COMPARISON OF OPEN-YARD WITH STALL MANURE.
COMPARISON OF MANURE WITH COMMERCIAL FERTILIZERS.

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BULLETIN

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THE VALUE OF BARNYARD MANURE.

BY C. E. THORNE AND J. FREMONT HICKMAN.

In one of the experiments of this Station 150 tenth-acre plots, arranged in 5 sections of 30 plots each, have been cropped with corn, oats and wheat, grown in succession, followed by two years in clover and timothy mixed, the cropping being so planned that each crop is represented each season. The test was begun in 1894, and we now have 8 crops each of the cereals and 7 hay crops of the first year and 6 of the second year. This experiment has been duplicated since 1895 at the Northeastern Substation at Strongsville, where 7 crops of corn, 6 of oats, and 5 of wheat have been harvested, with 5 hay crops of the first year and two of the second—the second year's hay crop having failed several times at the substation. All told, 62 crops have been harvested under the plan of the experiment. The five sections of plots in both tests are numbered alike and plots of the same number receive the same treatment. The full plan of the experiments is given in Bulletin 110, with diagrams showing the arrangement of the plots.

On Plot 18 of this test barnyard manure is applied to the corn and wheat crops, at the rate of 8 tons per acre to each crop, and on Plot 20 the same manure is used at the rate of 4 tons per acre on each crop, there being a total application every 5 years of 16 tons of manure to Plot 18 and 8 tons to Plot 20. The manure is taken from flat, open yards, where it has accumulated for several months during the fall and winter, and has been subjected to the conditions which affect the ordinary, open-yard manure of the average Ohio farm, conditions which involve very considerable losses. For both corn and wheat the manure is applied to the surface as a top dressing. It is put on with the manure spreader. The results of this test are given in Table I, which shows the average manured yield for each crop for the period over which the experiment has been conducted, the

mean unfertilized yield for the same period of the two plots nearest the manured plot, the average increase in yield due to the manure and the value of this increase, counting corn at 33⅓ cents per bushel, oats at 25 cents and wheat at 66⅔ cents, corn stover at $3. 00 per ton, straw at $2.00 and hay at $6.66⅔.

TABLE I:—INCREASE PER ACRE FROM BARNYARD MANURE IN FIVE-YEAR ROTATIONS.

Crop and treatment	Wooster.				Strongsville.			
	Plot 18.		Plot 20.		Plot 18.		Plot 20.	
	Grain.	Straw or stover.	Grain.	Straw or stover.	Grain.	Straw. or stover.	Grain.	Straw or stover
CORN.	Bushels.	Pounds.	Bushels.	Pounds.	Bushels.	Pounds.	Bushels.	Pounds.
Manured yield.....	44.25	2,096	40.36	1,922	37.20	1,806	32.96	1,734
Unfertilized yield....	30.76	1,602	31.26	575	25 87	1,655	26 04	1,603
Increase.....	13.49	494	9.10	347	11.33	251	6.92	131
Value of increase....	$ 4 50	$ 0 74	$ 3 03	$ 0 52	$ 3 78	$ 0 37	$ 2 31	$ 0 19
OATS.								
Manured yield.....	40.05	1,551	34.86	1,337	37.56	14.69	35.09	14 18
Unfertilized yield....	30.56	1,084	29.35	1,089	31.28	12.08	31.60	12 86
Increase.....	9.49	467	5.51	248	6.28	2.61	3.49	1 32
Value of increase....	$ 2 37	$ 0 47	$ 1 38	$ 0 25	$ 1 57	$ 0 28	$ 0 87	$ 0 13
WHEAT.								
Manured yield.....	13.42	1,702	11.62	1,466	12.57	12.62	8.94	8 63
Unfertilized yield....	6.84	742	6.99	756	3.96	3.39	3.85	3.31
Increase.....	6.58	960	4.63	710	8.61	9.23	5.09	5.32
Value of increase....	$ 4 38	$ 0 96	$ 3 08	$ 0 71	$ 5 74	$ 0 92	$ 3 39	$ 0 53
HAY.	1st yr. lbs	2d. yr. lbs	1st yr. lbs	2d yr. lbs	1st yr. lbs	2d yr. lbs	1st yr. lbs	2d yr. lbs
Manurde yield.....	2,923	3,593	2,474	3,242	2,420	2,540	2,176	2,770
Unfertilized yield....	1,678	2,586	1,657	2,537	1,498	2,240	1,509	2,417
Increase.....	1,245	1,007	817	705	922	300	667	358
Value of increase....	$ 4 15	$ 3 36	$ 2 72	$ 2 35	$ 3 07	$ 1 00	$ 2 23	$ 1 18
Total value of increase.....	$ 20 93		$ 14 04		$ 16 71		$ 10 83	
Value of increase per ton of manure.	1 31		1 75		1 04		1 35	

It will be observed that a larger increase has been obtained at Wooster than at Strongsville, and that in every case the value of the increase per ton of manure is greater from the smaller application of manure, although if we count the cost of manure at only that of getting it from the barnyard to the field the net profit per acre is much greater from the larger application of manure.

Additional light is thrown upon this point by another series of the experiments at Wooster, in which corn, oats and wheat have each been grown continuously on the same land during the same period covered by the rotation experiments just described. In this test Plot 5 receives 2½ tons of manure each year and Plot 6 receives 5 tons, the manure, as in the other test, being applied as a top dressing and with the manure spreader. The average results of the 8 crops of each grain harvested are shown in Table II:

TABLE II:—INCREASE PER ACRE FROM BARNYARD MANURE ON CROPS GROWN CONTINUOUSLY.

Crop and treatment.	Plot 5.		Plot 6.	
	Grain.	Straw or stover.	Grain.	Straw or stover.
CORN.	Bushels.	Pounds.	Bushels.	Pounds.
Manured yield	35.72	1,649	43.33	1,950
Unfertilized yield	25.33	1,307	24.46	1,272
Increase	10.39	342	18.87	678
Value of increase	$ 3 97	.....	$ 7 30	.....
Value of increase per ton of manure	1 59	.....	1 46	.....
OATS.				
Manured yield	30.81	1,045	35.86	1,384
Unfertilized yield	26.87	993	26.95	1,017
Increase	3.94	52	8.91	367
Value of increase	$ 1 04	.....	$ 2 60	.....
Value of increase per ton of manure	41	.....	52	.....
WHEAT.				
Manured yield	12.41	1,392	15.47	1,728
Unfertilized yield	8.43	921	8.43	929
Increase	3.98	471	7.04	799
Value of increase	$ 3 12	.....	$ 5 50	.....
Value of increase per ton of manure	1 25	.....	1 10	.....

Table II indicates a considerably larger increase from manure, both in quantity and value, in the corn crop than in either of the other crops, while that from oats is much smaller than that from wheat.

Although the separate applications of manure are lighter in the continuous than in the rotative cropping, the total weight applied in the course of a five-year period is heavier, as shown by Table III:

TABLE III:—TOTAL WEIGHT OF MANURE APPLIED IN FIVE YEARS, WITH VALUE OF INCREASE PER TON OF MANURE.

Experiment and plot.	Total weight of manure in five years.	Value of increase per ton of manure.
Rotation, Plot 20	8 tons	$1 75
Continuous, Plot 5	12½ "	1 59 on corn. 41 on oats. 1 25 on wheat.
Rotation, Plot 18	16 "	$1 31
Continuous, Plot 6	25 "	1 46 on corn. 52 on oats. 1 10 on wheat.

These figures seem to show very clearly that where the supply of manure is scanty it should be spread over as large an area as possible.

THE COMPOSITION OF MANURE.

In Table IV is shown the percentage of water, nitrogen, phosphoric acid and potash found in animal manures by various American analyses.

TABLE IV.—PERCENTAGE COMPOSITION OF MANURE.

No.	Kinds of manure.	Water.	Nitrogen.	Phosphoric acid.	Potash.	Authority.
	Cow Manure.					
1	Fresh with straw.....	81.4	0.47	0.32	0.48	Cornell Univ. Exp. Sta., B 27.
2	" " "	75.2	0 43	0.29	0.44	" " " " " 56.
3	" " "	71.7	0 43	0.30	0 48	Conn. Exp. Sta., Rpt., 1889.
4	Fresh without straw..	85.3	0.53	0.16	0.36	" " " " 1889.
5	" " " ..	.....	0.50	0.33	0.44	Cornell Univ. Exp. Sta., B 27.
6	" " " ..	84 9	0.54	0.39	0.35	N. J. Exp. Sta. Rpt., 1899.
7	From covered shed....	82.4	0.42	0.20	0 30	Conn. Exp. Sta. Rpt., 1890.
8	" open yard.....	67.0	0 55	0.51	0 85	Cornell Univ. Exp. Sta., B 27.
9	Leached.....	79.3	0.60	0.34	0.14	N. J. Exp. Sta. Rpt., 1899.
10	Dung only.....	85.1	0.34	0.43	0.22	" " " " 1899.
11	" "	.....	0.26	0.28	0.20	Cornell Univ. Exp. Sta., B 27.
12	Urine only.....	.....	0.32	.....	1.00	" " " "
	Average, 1 to 8....	78.3	0.48	0.31	0.45	
	Horse Manure.					
13	Fresh with straw.....	70.8	0.51	0.21	0.53	Cornell Univ. Exp. Sta., B 27.
14	" " "	72.0	0.49	0.37	0.90	" " " " "
15	" " "	48.7	0.49	0.26	0.48	" " " " " 56.
16	Fresh without straw..	.....	0.47	0.39	0.94	" " " " " 27.
17	From city stables.....	75.8	0.53	0.41	0.51	Conn. Exp. Sta. Rpt., 1889.
18	" " "	69.3	0.69	0.67	0.63	" " " "
19	From open yard.....	80.1	0.45	0.45	0.50	Cornell Univ. Exp. Sta., B 27.
20	Dung only (?).....	67.3	0.47	0.35	0.22	Conn. Exp. Sta. Rpt., 1889.
	Average, 13 to 20..	69.1	0.59	0.39	0.58	
	Mixed yard Manure.					
21	Open yard manure....	77.1	0.53	0.34	0 71	Conn. Exp. Sta. Rpt., 1889.
22	Open yard manure, old	54.7	0.46	0.72	0.16	" " " " 1889.
23	Barnyard manure.....	73.6	0.43	0.33	0.47	Mass. Hatch Exp. Sta., B 70.
24	" "	70.7	0.53	0.39	0 62	" " " " "
25	" "	63.5	0.69	0.52	0.68	" " " " "
26	" "	75.8	0.30	0.30	0 41	" " " " "
27	" "	77.0	0.33	0.29	0.55	" " " " "
28	" "	73.1	0.35	0.28	0.66	" " " " "
	Average, 21 to 28..	70.7	0.45	0.40	0.53	
	Sheep Manure.					
29	Fresh.....	59.5	0.77	0.39	0.59	Cornell Univ. Exp. Sta., B 56.
	Hog Manure.					
30	.....	74.1	0.84	0.39	0.32	Cornell Univ. Exp. Sta., B 56.
31	.....	.....	0.54	0.66	0.73	N. Y. State Exp. Sta., 9th Rpt.
32	.....	.....	0.57	0.83	0.37	" " " " "

Following is a description of the various samples:

1. Taken from a pile of 5 tons of fresh cow manure containing 9,278 lbs. excrement, 422 lbs. wheat straw and 300 lbs. plaster.

2. Average of 4 analyses of manure from 18 cows, bedded with cut wheat straw and the drops sprinkled with plaster.

3. Manure made by milch cows fed liberally on corn meal, bran, hay and roots.

4. Cow manure without litter. Feed: Hay as much as the cows would eat, 4 quarts wheat bran and 4 quarts mangolds.

5. Cow manure, solid and liquid, apparently without litter. Average of two experiments.

6. Fresh cow manure, solid and liquid.

7. Manure from milch cows fed on hay and stover—one feed of each per day —corn meal, wheat bran and a moderate quantity of various grains. The manure was kept closely packed in a manure house having a cement floor.

8. Manure from No. 1 after 6 months exposure in an open yard. The total weight of manure was reduced from 10,000 pounds to 5,125 pounds, and the total nitrogen, phosphoric acid and potash from 47, 32 and 48 pounds to 28, 26 and 44 pounds respectively, or by 41, 19 and 8 per cent.

9. Manure from No. 6, after being exposed to the weather for 131 days in such manner as to permit complete drainage. The total weight of manure was reduced by 49 per cent., and the nitrogen, phosphoric acid and potash by 46, 72 and 80 per cent. respectively.

10. The solid excrement of No. 6.

11 & 12. The solid and liquid excrement of 4 cows. Included in No. 5.

13 & 14. Manure from horses used in determining losses by weathering.

15. Manure from 4 horses and 1 colt; the horses fed hay, oats, corn meal and wheat bran; the colt, hay only.

16. Manure without bedding from 10 work horses, liberally fed on oats and hay.

17 & 18. Manure from N. Y. city stable.

19. Same as No. 14, after 5 months' exposure in open yard. During this time the total weight of manure was reduced by 57 per cent., that of the nitrogen by 60 per cent., that of the phosphoric acid by 47 per cent., and that of the potash by 76 per cent.

20. Fresh dung from a horse fed daily with 14 pounds of timothy hay and 4 quarts of oats with cracked corn. Somewhat dried.

21. Manure taken from a heap containing the accumulations from young growing cattle and a few horses. Liberal quantities of bran, a few oats and a little corn meal with good timothy made up the feed.

22. Old yard manure, made by young cattle fed in yard on hay. It represents well rotted yard manure in its usual washed condition.

23 to 28. No data.

A large number of analyses of manures, including some of the foregoing, together with many European analyses, have been collected by Prof. Storer in his "Agriculture in some of its Relations with Chemistry," Vol. II. These are averaged below:

Kind of Manure.	Water.	Nitrogen.	Phosphoric acid.	Potash.
Manure of cattle, 53 analyses	.....	0.58	0 28	0 53
" " horses, 17 "	.....	0.59	0.34	0.52
" " sheep, 11 "	66 6	0.68	0.40	0.75
Yard manure, 36 analyses	73 1	0.51	0.33	0.53

The differences shown in these analyses show the range of variation in manures. From these analyses we may assume that the average manure of the stable and barnyard will carry fertilizing constituents approximately as indicated below:

	Pounds per ton.		
	Nitrogen.	Phosphoric acid.	Potash.
Cow manure with straw, fresh from stable	9	6	9
Horse manure with straw, fresh from stable	10	6	10
Mixed manure from yard, spring	10	7	12
Mixed manure from yard, fall	10	9	12

Of course, these quantities will vary with the conditions of the manure. Manure which contains much straw or has been "fire fanged" by heating, or which has been subjected to some leaching, will be inferior in composition.

These analyses show that the manure of horses, cattle and sheep is relatively deficient in phosphoric acid, a point which is further emphasized by the hunger for phosphoric acid shown by soils which have been long in cultivation and fertilized only with barnyard manure; while common experience demonstrates the readiness of nitrogen to escape from the fermenting manure heap in the form of ammonia. In the hope of securing some light upon the possibility of re-enforcing manure with phosphoric acid, and at the same time reducing the loss of ammonia, the following experiment was begun in the spring of 1897:

THE RE-ENFORCEMENT OF MANURE—COMPARISON OF OPEN-YARD WITH STALL MANURE.

A lot of manure, taken from an open yard, where it had accumulated during the winter from daily cleaning out of the stable behind a herd of dairy cows, which had been liberally fed on bran, gluten meal, corn meal, hay and silage, was divided in the spring into four parcels. On one parcel the finely ground phosphatic rock, from which acid phosphate is made by treating with sulphuric acid, and which, in its untreated condition, is known in the South as "floats", was dusted as the manure was thrown into a pile; on a second parcel acid phosphate was dusted; on another the crude potash salt known as kainit, and on another, land plaster, or gypsum, these materials all being used at the uniform rate of 2 pounds per hundred pounds of manure, or 40 pounds per ton. At the same time a lot of manure was taken from box stalls, where it had accumulated under the feet of animals which were kept continuously in their stalls, being given sufficient bedding to keep them clean without cleaning out the stalls, and similarly treated.

At first the animals furnishing this stall manure were bulls, fed on a maintenance ration only; but for two seasons the manure has been made by fattening steers. After a few weeks the manures thus treated, together with two lots of untreated manure, one taken from the yard and one from the stall, are spread upon land that is being prepared for corn, the manure being distributed over the surface before plowing, at the uniform rate of eight tons per acre. The corn crop is followed by wheat and that by clover or soy beans, the latter crop having been grown during the first three seasons, owing to the failure of the clover. The soy beans were plowed under. The land under experiment is divided into three sections of twenty plots each, so that each crop is represented each season.

TABLE V.—STATISTICS OF YIELDS IN BARNYARD MANURE TEST.

Plot No.	Corn.					
	1900.		1901.		5-year average.	
	Ear corn.	Stover.	Ear corn.	Stover.	Ear corn.	Stover.
	Bushels.	Pounds	Bushels	Pounds	Bushels	Pounds
1	38.74	2,176	46.46	2,384	41.19	1,853
2	67.66	3,424	68.17	3,840	59.42	2,780
3	73.31	3,840	66.29	3,808	61.08	2,892
4	44.62	2,688	34.74	2,004	37.14	1,785
5	74.86	3,712	70.74	3,840	59.29	2,709
6	79.82	4,064	70.63	4,640	61.68	2,998
7	46.69	2,064	40.29	2,320	36.55	1,613
8	75.38	4,224	66.17	3,920	57.70	2,753
9	77.94	3,840	65.49	4,880	60.35	2,952
10	53.31	2,752	37.49	2,240	40.02	1,880
11	32.00	2,080	54.29	3,840	40.77	2,161
12	59.31	3,008	81.03	4,560	60.64	2,893
13	68.11	3,680	72.34	4,538	62.86	3,156
14	36.22	2,256	35.83	2,000	37.95	1,756
15	61.66	2,912	51.49	3,360	53.70	2,498
16	68.58	3,552	70.40	3,840	59.47	2,791
17	43.26	2,288	43.43	2,400	39.75	1,857
18	53.82	2,608	52.97	2,960	47.90	2,202
19	57.20	2,720	52.23	2,880	48.94	2,160
20	47.09	2,400	45.43	2,640	41.39	1,881

TABLE V (Continued).—STATISTICS OF YIELDS IN BARNYARD MANURE TEST.

Plot No.	Wheat						Hay 1901
	1900		1901		4-year average		
	Grain	Straw	Grain	Straw	Grain	Straw	
	Bushels	Pounds	Bushels	Pounds	Bushels	Pounds	Pounds
1	6.53	600	4.00	784	8.48	931	2,208
2	21.60	1,744	13.47	1,914	18.65	1,941	3,520
3	29.07	2,352	16.67	2,328	22.45	2,289	4,160
4	6.93	576	2.13	272	7.48	699	2,384
5	22.27	1,864	12.13	1,672	18.48	1,867	3,760
6	24.80	2,112	14.67	1,904	20.75	2,110	4,032
7	3.87	328	2.13	384	6.72	685	1,678
8	10.67	880	10.93	1,552	15.25	1,648	2,832
9	15.87	1,224	14.40	1,984	17.98	1,909	3,520
10	4.80	560	3.20	608	8.11	821	2,672
11	8.13	904	3.73	688	9.58	1,053	2,624
12	17.20	1,390	10.27	1,624	16.68	1,792	2,960
13	21.47	1,672	13.47	2,264	19.15	1,999	3,184
14	5.60	464	2.13	416	6.64	673	2,280
15	11.47	992	7.47	1,136	12.78	1,393	2,736
16	18.27	1,384	10.80	1,720	14.82	1,587	3,472
17	7.33	760	2.00	552	6.85	781	2,880
18	11.07	936	3.60	600	9.65	1,025	3,280
19	13.07	1,024	5.73	840	11.58	1,209	3,696
20	6.13	624	2.40	432	7.19	829	2,784

Up to the present time there have been harvested in this test five crops of corn, four of wheat and one of hay.

TABLE VI.—BARNYARD MANURE TEST AT MAIN STATION.

Increase per acre and its value.

Plot No.	Manure and treatment	Average increase per acre					Total value of increase	Cost of treatment	Net value of increase	
		Corn—5 crops		Wheat—4 crops		Hay—1 crop			Per acre	Per ton of manure
		Ear-corn	Stover	Grain	Straw					
		Bushels	Pounds	Bushels	Pounds	Pounds				
2	Yard, with floats	19.58	949	10.50	1,087	1,253	$20.21	$1.50	$18.71	$2.34
3	Stall, "	22.59	1,085	14.64	1,512	1,835	26.54	1.50	25 04	3.13
5	Yard, with acid phosphate	22.35	982	11.25	1,172	1,611	22.96	2.25	20.71	2.59
6	Stall, " "	24.93	1,327	13.78	1,421	2,119	27.97	2 25	25 72	3.21
8	Yard, with kainit	19.99	1,051	9.06	919	823	17.94	2 50	15 44	1.93
9	Stall, "	21.49	1,161	10.34	1,133	1,179	20.86	2.50	18.36	2.29
12	Yard, with gypsum	20.82	867	8.09	866	451	16.00	1.20	14.80	1.85
13	Stall, "	23.97	1,266	11.52	1,199	789	21 40	1.20	20.20	2.52
15	Yard, untreated	15.15	709	6.07	684	256	11.70	.....	11.70	1.46
16	Stall, "	20.32	968	8.04	842	792	17.07	.....	17.07	2.13

The statistics of this experiment for 1897, 1898 and 1899 are given in Bulletin 110. In Table V are given the detailed results for 1900 and 1901, and in Table VI is given the average increase for each of the manured plots during the full period of the test, with its value, this being computed as in Table I, together with the cost of treating the manure, the net value of increase and the net value per ton of manure.

The table shows at a glance that each of the materials added to the manure has increased its effectiveness, both total and net. This point may be more clearly exhibited by the following statement, showing the value of the net increase for the different applications over and above that given by the untreated manures:

TABLE VII.—ADDITIONAL VALUE OF INCREASE RESULTING FROM TREATMENT OF MANURE.

Manure treated with—	Per acre.		Per ton of manure.	
	Yard manure.	Stall manure.	Yard manure.	Stall manure.
Kainit	$3.74	$1.29	$ .47	$ .16
Gypsum	3.10	3.13	.39	.39
Floats	7.02	7 97	.88	1.00
Acid phosphate	9.01	8.65	1.13	1.08

These results show that while the prevention of escape of ammonia, which seems to be the only effect that can be ascribed to kainit and gypsum in common, has abundantly justified the use of these materials, yet the additional increase resulting from the use of phosphatic materials has been so large as to demonstrate beyond all doubt the superiority of these materials for the purpose in view.

It is probable that floats and acid phospate are quite as effective conservers of ammonia as gypsum or kainit, while in addition to this office they also re-enforce the manure in that constituent in which chemical analysis and practical experience show it to be deficient, and thus largely augment its effectiveness.

One of the purposes of this experiment was to study the effect of contact with manure upon the availability of the phosphoric acid in the untreated, pulverized rock; hence the use of floats. This material is converted into acid phosphate by the addition of approximately an equal weight of sulphuric acid, hence the non-acidulated floats contains nearly twice as large a percentage of phosphoric acid as does the acid phosphate made from it. In the untreated rock, however, the phosphoric acid becomes available so slowly as to make

some form of treatment, calculated to increase its solubility, absolutely essential to its economical use. This experiment shows that the manure is having this effect to a limited degree, and it seems reasonable to expect that if the floats were so used as to remain in contact with the manure for a longer period, as by dusting the floors of the stable with it, or incorporating it at an earlier date in the manure accumulating in the box stalls or barnyard, this effect would be increased.

A part of the above described experiment has been duplicated at the Strongsville substation where, in a similar rotation of corn, wheat and clover, two plots have been dressed with yard manure, made from horses and sheep. To one plot (No. 18) the manure has been applied as it came from the yard, while for the other plot (No. 19) the manure has first been sprinkled with acid phosphate, following the plan of the experiment at the main station. The two plots in this test, therefore, correspond in treatment with Plots 15 and 5 in the manure test at the main station. The results of this test are given in Table VIII, the records of Plots 15 and 5 at the main station being repeated for ease of comparison.

It appears from this table that, while the untreated yard manure has given an almost identical total increase in the two tests, the treated manure shows a much larger increase at the main station than at the substation, this result being in harmony with the smaller effect of manure at the substation in the five year rotation first described.

It remains for further investigation to determine the cause of this difference in general effectiveness of manure on the two soils. Even with the smaller apparent effect of the treatment of manure at the substation, however, the increased return from the treated manure is still amply sufficient to justify the cost of treatment.

COMPARISON OF MANURE WITH FERTILIZERS.

The experiments described above give us one method by which the value of barnyard manure may be estimated; that is by showing the value of the increase of crop which it may be made to produce. but there is another question which must be considered and that is, what can one afford to pay for manure, as against commercial fertilizers? Some light upon this question also is given by the experiments under consideration, in each of which there are certain plots which have been dressed with such fertilizers.

In the test at the main station Plot 19 receives on the corn crop 210 pounds per acre of a mixture of tankage, acid phosphate, and muriate of potash, made up to analyze about 3½ per cent. ammonia, 12 per cent. available phosphoric acid and 2½ per cent. potash. At the substation four plots are dressed with four different brands of

TABLE VIII.—BARNYARD MANURE TEST AT SUB-STATION.

Increase per acre and its value.

Plot No.	Plan and treatment of manure	Average increase per acre					Total value of increase	Cost of treatment	Net value of increase	
		Corn		Wheat		Hay—			Per acre	Per ton of manure
		Ear-corn	Stover	Grain	Straw					
	MANURE UNTREATED	Bushels	Pounds	Bushels	Pounds	Pounds				
15	Wooster	15.15	709	6.07	684	[3] 256	$11.70	.....	$11.70	$1.46
18	Strongsville	[1] 17.18	642	[2] 5.37	489	[2]342	11.90	.....	11.90	1.49
	MANURE WITH ACID PHOSPHATE									
5	Wooster	22.35	982	11.25	1,172	[3]1,611	22.96	$2.25	20.71	2.59
9	Strongsville	[1] 18 57	658	[2] 8.72	912	[2] 438	15.37	2.25	13.12	1 64

[1] 5-year average.
[2] 3-year average.
[3] one crop.
In this test at the substation the wheat crop failed in 1899 and land was sown to oats.

commercial fertilizers, and four plots with tankage, acid phosphate and muriate of potash, mixed to duplicate the claimed analyses of these different brands, the average composition of the fertilizer thus used on the eight plots being equivalent to about 2½ per cent. ammonia, 8½ per cent. available phosphoric acid and 3⅓ per cent. potash. These fertilizers are applied at the rate of 200 pounds per acre. At the main station the fertilizers, like the manure, are applied only to the corn crop, but at the substation they are used on both corn and wheat. Table IX shows the outcome of this comparison:

TABLE IX.—INCREASE FROM COMMERCIAL FERTILIZERS.

Place of test	Average increase per acre					Total value of increase	Cost of fertilizers*	Net value of increase
	Corn		Wheat		Hay			
	Ear-corn	Stover	Grain	Straw				
	Bushels	Pounds	Bushels	Pounds	Pounds			
Wooster	8.09	288	4 51	296	880	$ 9.36	$2.65	$6.71
Strongsville	6.27	142	10 23	801	614	12.03	4.80	7.23

*Estimated cost of proprietary fertilizers of composition given, including handling and application.

It appears from this table that there has not been much difference in the value of the net increase from fertilzers at the two stations after deducting the cost of the fertilizer. It also appers in the case of fertilizers, as in that of manure, that a small dressing will produce a relatively greater effect than a large one; or, what is pratically the same thing, that the gross return per hundred pounds of fertilizer will be greater when the applications are made several years apart, thus giving time for larger utilization of the plant food in the fertilizers by successive crops. On the other hand, the actual profit per acre from the fertilizer may be greater from the larger or more frequent application.

Comparing Tables VIII and IX, we see that at the substation the total value of the increase produced by 400 pounds of a complete fertilizer, costing about $4.80, is a very little greater than that from eight tons of barnyard manure. So far, therefore, as immediate effect is concerned it would have been economical, on the soil under consideration, to use fertilizers rather than untreated yard manure, had the cost of the latter, spread upon the field, exceeded about sixty cents per ton. But if we compare the fertilizers with stall

manure or with manure that has been re-enforced with phosphoric acid, we see that its relative value may be very considerably increased.

It must be remembered, however, that the residual effect of barnyard manure is much greater than that of commercial fertilizers, and the farmer who is working his own land should take this point into consideration.

CONCLUSIONS

While it is evident that the experiments described in this bulletin must be continued over a much longer period of time before we can attempt to draw from them anything more than approximate conclusions, they already show that it will pay well to give more attention than is done on the average farm to the preservation of barnyard manure: first, by guarding it from the sources of loss which occur in the ordinary, open barnyard; and second, by treating it with materials calculated to reduce the losses from escaping ammonia on the one hand and to increase its content of phosphoric acid on the other.

To accomplish this purpose, acid phosphate appears to be the material producing the largest and most profitable immediate increase in effectiveness of the manure, but the experiments strongly suggest the possibility that the finely ground, phosphatic rock from which acid phosphate is made may be found an economical substitute for the latter, by using it as an absorbent in the stables and thus securing an intimate mixture with the manure in its fresh condition.

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